grown considerably. At this time a few adults and juveniles were in other parts of the quarry so it seemed that birds were entering and leaving the quarry.

By 14 March the "chicks", now better described as juveniles, were still in the eastern corner of the quarry. One adult attended them. On 18 and 19 March there were one adult and three juveniles in the eastern corner of the quarry.

On 2 April there were two juveniles alone in the eastern corner of the quarry and I presumed that they were the two that had been raised there. One, the larger of the two, had the crown darker than the back and the white wing stripe was well developed. The other had the crown the same colour as the back and the white wing stripe was less developed. I presumed this to be a sexual difference.

On 22 February 1986 there were some 15-20 birds in the quarry, including 5-6 juveniles, some of which were quite young while others had the white wing stripe. I judged that breeding had finished for the year and consequently could not say if breeding had taken place in the quarry or if the young had come from elsewhere.

Since this time the quarry has been fenced off and access to me denied. The water level, fed by a spring in the adjacent but connecting north quarry, which used to be regularly pumped out, has steadily risen some 1 metre or so, covering the flats and islands and some of the vegetation, and rendering it less attractive to waders. It is planned that the quarry will be filled in and will become a site for residential housing.

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NATURAL HISTORY NOTES ON THE MEGAMOUTH SHARK, *MEGACHASMA PELAGIOS*, FROM WESTERN AUSTRALIA

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ABSTRACT

The third known specimen of *Megachasma pelagios* and the first from the Indian Ocean washed ashore at Mandurah Estuary about 50 km S. of Perth, Western Australia on 18 August 1988. The 5.15 m male weighed 690 kg. It was frozen the same day and eventually preserved with formalin by intramuscular and intraperitoneal injections and immersion in a formalin-filled, plastic-lined hole. Approximately 1,660 litres of full-strength formalin were added to the water in the hole to make a 10% solution. The total cost of preservation was A$3,231. Permanent storage has yet to be arranged. Megamouth is classified in its own family Megachasmidae, but at least one authority considers it to be related to the basking shark, *Cetorhinus*. The six known specimens are from Hawaii, California, Western Australia and

Japan. Megamouth is a weak swimming, vertical migrating, harmless shark that feeds on plankton. Photographs of the specimen and comments on its taxjonomy, geographic distribution, feeding mechanism, and possible cookiecutter shark *(Isistius brasiliensis)* bite mark are presented.

INTRODUCTION

Megamouth I

The first specimen of a new family, genus and species of shark known colloquially as megamouth was encountered on 15 November 1976 about 42 km northeast of Kahuku Point, Oahu, Hawaii at about 21° 51' N and 157° 46' W. The 4.46 m male was entangled in a large parachute used as a sea anchor by a U.S. Navy research vessel at a depth of 165 m over water 4,600 m deep. The shark weighed 750 kg. Taylor, Compagno, and Struhsaker (1983) erected the new family Megachasmidae within the order Lamniformes. They described the species and named it *Megachasma pelagios* because of its great gaping mouth and the open sea over which it was caught. The stomach contained a large quantity of euphausiid shrimp, *Thysanopoda pectinata,* indicating that it was a filter feeder.

Megamouth II

Eight years after the first specimen was collected, on 29 November 1984, a second specimen of *M. pelagios* was caught in a gill net set no deeper than 38 m, 14 km off the east end of Santa Catalina Island, California at about 33° 25' N 118° 25' W (Lavenberg and Seigel 1985). The male shark was still alive, and measured 4.5 m in length with an estimated weight of 700 kg, about the same size as the first specimen. Gut contents included fragments of euphausiids, copepods, and the sea jelly, *Atolla vanhoeffeni.*

WESTERN AUSTRALIAN SPECIMEN

Megamouth III

At 9.00 am on 18 August 1988 the Fisheries Inspector at Mandurah, W.A., Derek Blackman, phoned the second author to report that a large, strange-looking beast had washed ashore near the entrance to Mandurah Estuary (32° 31' S and 115° 43' E). Upon inspection by Hutchins and Western Australian Museum (WAM) technician Nick Haigh two hours later, the identification of *M. pelagios* was confirmed. The specimen was a male 5.15 m long and weighed 690 kg.

Although details are sketchy, apparently surfboard riders sighted the shark the previous day in shallow water. The surfers tried to coax it into deeper water apparently believing it to be a small whale intent on beaching itself. On the morning of 18 August it was stranded. Although still alive when located, the shark died soon after its discovery.

The Mandurah Shire provided a frontend loader and truck. Workers dug a trench on the beach, lined it with concrete reinforcing mesh and rolled the shark onto the mesh in the trench. The shark and mesh were lifted by the frontend loader (Fig. 1) onto the truck and transported to a deep freezer at Kailis and France Pty. Ltd. in Osborne Park, Perth.

Figure 1. Megamouth, wrapped in wire mesh, is lifted from the beach at Mandurah, W.A. and placed on a truck for the journey to Perth on 18 August 1988.

The following discussion includes a description of the logistics of dealing with an unexpected 5 m shark and natural history notes on the third known specimen of this unusual fish.

PRESERVATION

Three days after freezing, the frozen shark was placed on public display on a flatbed trailer for three hours in a shaded parking lot of the WAM (Fig. 2). The male's claspers and the prolapsed rectum were visible. Crow et al. (1990) have reported on the protrusion of the valvular intestine in eight species of captive carcharhinid sharks. The specimen was viewed by over 3,600 people and then returned to the freezer. The *West Australian* newspaper ran stories and a photo on 19, 20, 22 August 1988, and the *Sunday Times* published an article and photograph of megamouth on 30 October 1988.

Figure 2. Frozen megamouth on display in parking lot of the Western Australian Musuem in Perth on 21 August 1988. Note the large mouth and claspers. The rectum is everted through the cloaca.

On 15 September 1988 work began on the construction of a temporary preservation tank. A large hole was excavated by backhoe on WAM property in Fremantle. A coffin-shaped hole (Fig. 3) was dug to accommodate the spread pectoral fins and to reduce the volume of formalin needed. The hole was padded with old sheets of black plastic and corrugated cardboard. Costs of preservation supplies are indicated in Table 1.

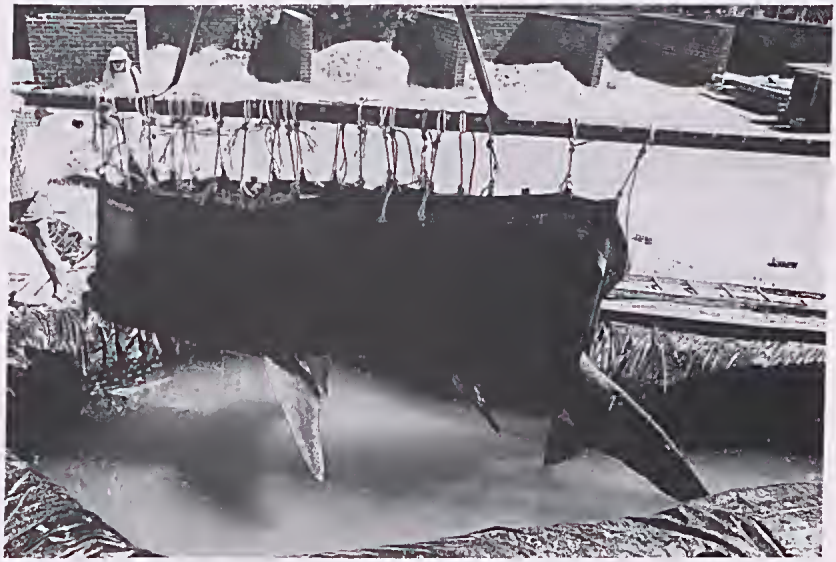

Figure 3. Megamouth in plastic mesh sling suspended from rails over plastic lined, formalin-filled preservation pit on WAM property in Fremantle.

Two sheets of 0.2 mm thick black plastic swimming pool liner were welded together. The edges of this double liner were held down with the sandy soil removed from the hole (Fig. 3). The padded and lined hole was filled with water from a nearby fire hydrant to test its integrity. After several days it was obvious that the liner was not leaking.

Megamouth III was removed from the freezer and placed on a car transport trailer with a fork lift borrowed from the freezer works. The trailer and shark were weighed at a truck scale. On the return trip the empty trailer was weighed. The frozen weight of megamouth was 690 kg $\pm$ 20 kg accuracy of the truck scale.

A crane was hired to lift the sling containing the frozen shark into the water-filled hole. The floating megamouth was covered with old carpet and left for the weekend. By the following Monday it had sunk to the bottom and was thawed.

About half of the water was pumped from the hole leaving approximately one m which facilitated rolling the fish for measurements. These 73 measurements are given in Berra and Hutchins (1990) along with the same measurements from the holotype (Taylor, et al. 1983).

Megamouth was rolled onto a stretcher of woven, heavy duty, plastic mesh (similar to garden shade cloth). Loops were stitched into the top edge during manufacture. More loops were located toward the head end because it supported the bulk of the weight. Holes were cut in the mesh when the sling was put around the fish to allow the pectoral fins and claspers to stick out (Fig. 3). Ropes attached the loops to two steel rails arranged in a V-shape to prevent the head from being squeezed. The rails were placed on top of timbers that spanned the hole thereby suspending the fish and its sling.

Megamouth was injected with about 20 litres of approximately 30% formalin via 130 mm long needles of 2 mm diameter attached to 20 ml syringes. Formalin was injected in its muscles around the body and into the body cavity. A 1,300 mm long 1 cm diameter stainless steel tube was made into a needle by sharpening one end to a point. This was connected to a 20-litre tank and to a compressed air bottle. Forty litres of approximately 50% formalin were pumped deep into the specimen. Formalin could be seen leaking out of needle holes throughout the body due to the very soft flesh.

The hole was drained and clean water was added so that megamouth was covered with about 30 cm of water. Volume was crudely estimated from the flow rate and time. Approximately 1,660 litres of full strength formalin were added to the water. Workers used cartridge-type respirators while working with formalin. Breezy conditions helped prevent buildup of fumes. The hole was covered with steel gates from a nearby building followed by polyethylene sheeting held down by timbers and bricks. Roof foil insulation was added over the plastic and the entire structure was covered with chicken wire (Table 1).

Table 1. Cost of preserving Megamouth III in Australian dollars.

EXPENSE	$
Freezer storage	766.00
Backhoe @ $60/hour	60.00
Cardboard	31.00
Plastic liner	400.00
Trailer	36.00
Crane @ $60/hour	90.00
Mesh sling	302.00
Formalin 8-44 Imp. Gal. drums (55 U.S. Gal. drums)	1,440.00
Foil insulation	56.00
Chicken wire	40.00
Stainless steel tube	10.00
TOTAL	A$3,231.00

The formalin in the hole was analysed. It tested at 8.25% (3.3 gm/100 ml) on 21 October 1988. This fell to 4.25% (1.7 gm/100 ml) by 15 December 1988. On 13 January 1989 400 litres of concentrated formalin were added to the solution in the hole. This brought the formalin concentration to 11.75% (4.7 gm/100 ml). As of this writing (February 1991), megamouth is still in the formalin-filled hole awaiting construction of a permanent storage or display tank.

Taxonomy

Maisey (1985) suggested that *Megachasma pelagios* is the primitive sister group of all other extant lamniforms based upon similarities in jaw suspension and dental array. He concluded that *Megachasma* and *Cetorhinus*, the basking shark, form a monophyletic group of specialised filter-feeding lamniforms that could be included in the Cetorhinidae. He considered the Cetorhinidae to be the sister group of the threshers (Alopidae) plus the mackerel sharks (Lamnidae). However, Compagno (1990) rejected the idea that megamouth is a cetorhinid and considered it to be the primitive sister group to the Alopiidae and the Cetorhinidae plus Lamnidae. Until further studies clarify these relationships we prefer to retain the family Megachasmidae.

Distribution

M. pelagios is one of three very large species of filter-feeding sharks. The other two are the basking shark, *Cetorhinus maximus* and the whale shark, *Rhiniodon typus*. Both are strong swimmers and are widely distributed. Basking sharks are a coastal-pelagic species found in cold to warm temperate waters of the continental shelves. Whale sharkes are circumglobal in tropical and warm temperate seas (Compagno 1984). Megamouth is considered to be much less active and a much poorer swimmer than either basking or whale sharks because of its flabby body, soft fins, asymmetrical tail, lack of keels and weak calcification (Compagno 1984).

In January 1989 a fourth specimen of megamouth shark washed ashore in Hamamatsu, Japan (34° 42' N and 137° 42' E) (Nakaya 1989). The dead specimen was photographed, but unfortunately, washed back out to sea and was not saved. Photographs reveal it to have been a male approximately 4 m long.

The following June, another megamouth was netted in Suruga Bay, Japan (35° 00' N, 138° 30' E) (Miya *et al.* in press). the 4.9 m individual was released alive.

A sixth specimen became entangled in a 365 m drift net about 11 km offshore of Dana Point, California (33° 28' N and 117° 42' W, — approximately 50 km from the site of capture of Megamouth II between Los Angeles and San Diego) on 21 October 1990. It too was a male and measured 4.9 m long (Robert Lavenberg, Los Angeles County Museum, personal communication). This live specimen was videotaped and tagged with two sonic transmitters by Don Nelson of California State University at Long Beach. It was released and followed for two days. Megamouth remained at about 15 m during the night then dove to 150 m at dawn. It ascended to shallow waters again at dusk (Anonymous 1991). Details of its vertical migration will be published in a future scientific paper (Lavenberg, personal communication).

Megamouth is now known from the eastern, central and western Pacific,

and from the eastern Indian Ocean (Fig. 4). It is likely that this species, like the two other gigantic filter feeding shark species, is wide-ranging. It is probably just a matter of time and good luck before Atlantic specimens of this species are found.

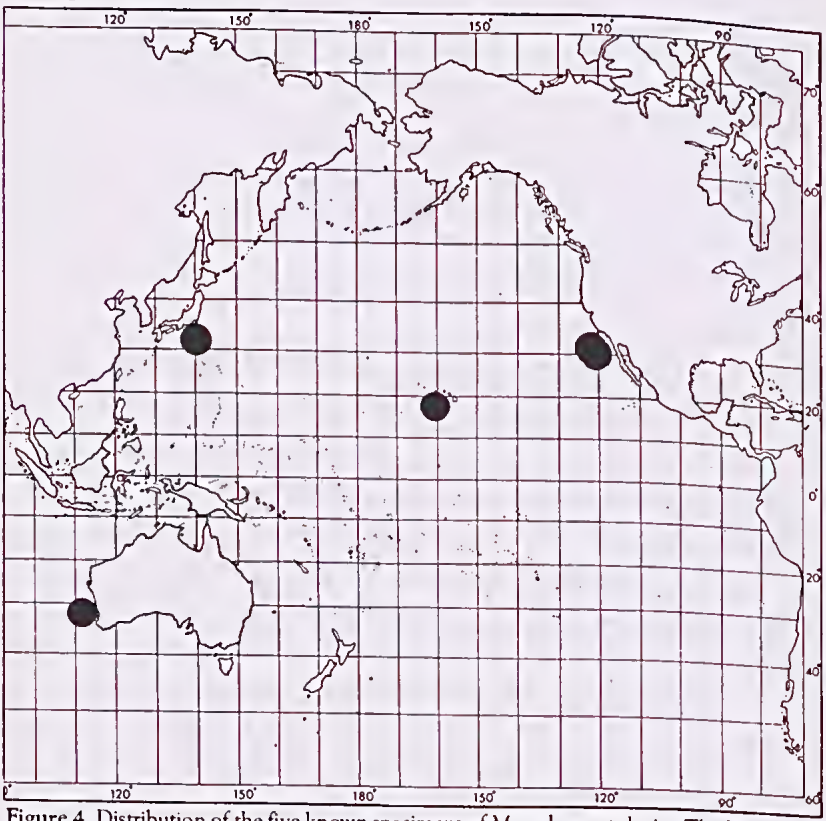

Figure 4. Distribution of the five known specimens of *Megachasma pelagios*. The Hawaiian, first Californian, and Western Australian specimens have been preserved for future study. The Japanese specimen washed out to sea and was lost. The second Californian specimen was released alive with a sonic transmitter.

Mouth, tongue and teeth

Megamouth has a broadly rounded, very short snout with a huge terminal mouth that extends well behind the eye (Fig. 2). The jaws are studded with many very small hooked teeth. Figure 5 shows the teeth, the huge, thick, broadly rounded tongue that almost fills the mouth cavity, and the broad, toothless patch on the upper jaw symphysis. Presumably the tongue forces food-laden water across the small, densely packed grillrakers when the mouth closes thereby straining food particles. It has been speculated, but not confirmed, that the mouth is bioluminescent and attractive to plankton thus allowing the slow swimming shark to acquire enough food to support its great mass (Diamond 1985). These features have been described in detail by Taylor, et al. (1983). Compagno (1990) suggested that megamouth feeds by expanding its buccal cavity and sucking its prey into its mouth.

Figure 5. Ventral-lateral view of the oral cavity of the frozen megamouth laying on its left side on 21 August 1988. Note the huge tongue, small teeth, and bare patch at the maxillary symphysis.

Possible cookiecutter shark wounds

The Western Australian specimen has a circular crater-like wound just above gill slits 2-3 (Fig. 6). Taylor, et al. (1983) reported similar scars on the throat and behind the right pectoral fin on the type specimen of *M. pelagios*. They suggested that these scars represent bite marks of the cookiecutter shark, *Isistius brasiliensis*.

Figure 6. Head of megamouth on beach at Mandurah, W.A. on 18 August 1988. Note possible cookiecutter shark bite above the 2-3 gill slit.

Similar crater wounds have been reported on various species of toothed and baleen whales (Mackintosh and Wheeler 1929; Van Utrecht 1959), pelagic fishes such as marlin and tuna (Jones 1971), the rubber sonardomes of nuclear submarines (Johnson 1978), and on northern elephant seals, *Mirounga angustirostris* (LeBoeuf, McCosker and Hewitt 1987).

Isistius brasiliensis is a small (maximum total length of 50 cm) oceanic and circumtropical shark usually found at midwater depths from 85-3,500 m (Compagno 1984). It is presumed to be a vertical migrator on a diel cycle spending the daytime in deep waters and ascending to midwater depths and to the surface at night. A similar pattern in response to food movements has been suggested for *M. pelagios* by Taylor, et al. (1983) and by the sonic tracking of Megamouth V (Lavenberg, personal communication). The slow swimming speed of megamouth would make it easy prey for the active cookiecutter shark (Diamond 1985).

I. brasiliensis is facultative ectoparasite that attaches to its prey with the help of suctorial lips and a modified pharynx. With a twist of its body the large saw-like teeth of the lower jaw cut a conical plug of flesh from the sides of its prey leaving a crater-like wound (Compagno 1984: 94).

ACKNOWLEDGEMENTS

The main responsibility for preserving megamouth fell to Nick Haigh. He handled this huge task with his usual efficiency and good humour. John Bass lent his expertise to the measuring process. Kailis and France Pty. Ltd. offered the use of their freezer which was vital to the storage of megamouth immediately after its discovery. The Mandurah Shire and its workers facilitated the recovery of megamouth from the beach. K. Petryk printed the black and white photos from our colours slides. We appreciate all of this help.

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FROM FIELD AND STUDY

Notes on the fauna of a remnant bushland in Victoria Park — Remnant areas of bushland in the inner metropolitan area contain examples of the fauna that would have existed over large areas before subdivision for housing. A one hectare block on the corner of Berwick Street and Hillview Terrace, Victoria Park has large numbers of native plant species — three banksias, a number of Christmas Trees and many small flowering shrubs which are not apparent from the road. The soil type is Bassendean Sand.

A study was made of the site from 18 to 27 November 1990. Six pitfall traps of 50cm deep, 17cm diameter PVC piping were placed 8 metres apart and connected by a 50m long, 30cm high fence of aluminium flywire mesh. Each pit was covered at the bottom by flywire to prevent burrowing animals from escaping. The pits were checked daily at 6am and all species were recorded and vertebrates were weighed, measured and released. Bird species were also recorded at this time.

The ten day study in spring found that at least four species of reptiles survive on the site. The fast moving *Ctenotus lesueurii* striped skink was particularly